

California Zero Emissions Climate Action Plan

By Dr. Hari Lamba

(Proposed)



Proposed in Book, “Brighter Climate Futures – A Global Energy, Climate & Ecosystem Transformation,” Dr. Hari Lamba, Regent Press, Berkeley, California, USA, September 2020. www.brighterclimatefutures.com. Image: Maps of the world, Copyright of Proposal © Harinder (Hari) Lamba 2020. Feel free to print this document or distribute electronically (unlimited). When you mention its contents, please reference this document or the above book.

California Climate Change Update to attached Proposal

October 24, 2021

California Climate Goals defined by Legislation (Top level ones)

1. Senate Bill 32 (Passed in 2016) requires the state to achieve 40% reduction in greenhouse gas (GHG) emission reductions by 2030.
2. CARB (California Air Resources Board) is the state agency that is tasked with coming up with a Scoping Plan by 2022 for meeting these GHG emission reduction goals – as such it has been holding open meetings and workshops to define the Plan. CARB also has the responsibility to oversee the state's Cap and Trade program (see main proposal).
3. Senate Bill 350 (passed 2015) and Senate Bill 100 (passed 2018) require the state to get 60% of all its electricity from renewable energy by 2030 and 100% from carbon free sources by 2045.

California Should Up its Ambitions

With other nations like the UK aiming for 68% GHG emission reductions and the EU aiming at 55% reductions by 2050, California should up its ambition and increase the GHG reduction target to within the 50-80% range. In addition, in cooperation with the other related state agencies, CARB needs to define a program to start REPLACING its fossil fuel electric power plants with Solar PV (photo-voltaic) plus battery power plants. Most added energy needed because of electrification (substituting fossil fuels by electrical energy) should come from distributed and rooftop Solar PV. The attempt by electrical utility companies to kill rooftop solar should be fought at every level, and so must the attempt to raise transmission access charges due to unneeded expansions in electrical transmission lines.

Overcoming the Variability of Renewable Energy

To overcome the variability aspect of renewable energy (when the sun is not shining or the wind is not blowing), the state should up its ambition to store large commercial quantities of solar and wind energy in small, medium and large battery systems, and green hydrogen produced mainly through electrolysis of water. It should put resources to the RDD&D (Research, Development, Demonstration & Deployment) for the statewide production, transport, storage and end uses of Green Hydrogen, but only that made from renewable energy. This is managed by the California Energy Commission (CEC).

Transitioning its Transportation to Zero emissions

Most of the state's GHG emissions come from transportation. The state needs to tie its programs for establishing electric vehicle charging with distributed solar plus battery production so that all of the added electric power needed to charge vehicles comes from renewables. In addition, distributed solar PV should be used along with hydrogen electrolysis units to produce green hydrogen for supply to fuel cell vehicles.

Note: For piecharts, the column of items on the right start at the 12 O-Clock position and go clockwise. For proposed plan, Coal is zero at the top and Renew Storage is at top left.

The Energy, Climate and Ecosystem Plan for California

Impact of Climate Change on California

California has taken good steps in the areas of car fuel emissions, battery electric cars, renewable energy electricity generation, and tighter standards on environmental and pollution regulations. However, California also has been suffering from the effects of Climate Change through droughts and wildfires, and some effects of heat waves, increased air pollution, ocean acidification and sea level rise. There was an extreme drought in 2014 that covered almost all of California, and in 2015 the drought cost agriculture about \$2.7 billion and more than 20,000 jobs, and in 2016 was followed by heavy rains that led to flooding that damaged highways, threatened rural areas and isolated coastal communities.

California has become increasingly subject to wildfires due to increased temperatures, and drought (dry times), often accompanied by high winds. From 1979-2013, the length of the fire season increased by about 19%, and since 1985, more than 50% of the wildfires have been thought to have been caused by Climate Change. Since 1990, the average annual number of homes lost to wildfires has increased by 300%, and the number of homes at risk from wildfires was estimated to be about 900,000 in 2017. About 35% of the wildfires have started in high risk areas. Matters have been made worse by people building homes in forested areas. In 2017, 2018 and 2019 California has suffered from catastrophic wildfires in many of its forests. In 2017 there was a catastrophic wildfire in Sonoma County and in 2018 another one that essentially burned down the town of Paradise. Both were in Northern California. In 2019, the northern Kincadee wildfire, again in Northern California, has been devastating. In 2019, till early November there were about 6,400 wildfires, that burned about 250,000 acres and about \$163 million was spent in fire suppression.

The other bad news in relation to California wildfires is that in 2018 the estimated carbon dioxide emissions were 45 million metric tons. This wiped out some of the benefits of decreasing emissions down to 424 MMTCO_{2e} (hence doing better than the 431 MMTCO_{2e} goal for 2020), that were being tracked and are described above. This is also bad, because it points to one of the possible scenarios of a runaway greenhouse effect that Climate Change makes things happen that increase carbon dioxide emissions.

Status of Energy and Climate Change Efforts in California

While there has been foot dragging and often outright opposition at the national or federal level for solutions to Climate Change, the state of California located on the west coast of the US has forged ahead. There are three aspects of California's Energy and Climate situation: (a) California has achieved much in the past decades, both in energy and emissions; (b) There is much the world can learn from California (as it has led in many actions); (c) California still faces immense challenges, especially in transportation, electrification, high jet fuel use and in fossil fuel based electric power generation. Because of the energy and emissions challenges that remain, and challenges in the forestation/wildfire and coastal ecosystems front, a Plan is proposed for California that will help it in achieving the ambitious goals it has set for itself, which parallel what we are trying to do globally here.

California Achievements and State Government Goals

- If California was a country, it would be the fifth largest economy in the world. In 2006, California passed legislation (SB32) to reduce Greenhouse Gas Emissions by 2020 to the state's 1990 levels (431 MMTCO_{2e} – million metric tons of Carbon dioxide equivalent). It achieved that in 2017, when the emissions were 424 MMTCO_{2e}). California was serious about the **Kyoto Protocol goals** and was one of the few "countries" to achieve its commitments as per Kyoto. Inspired by the state, many of the cities in California, including the city of El Cerrito, also set targets and achieved them as per the Kyoto targets.
- Utility Scale Solar and Wind electric power generation increased from 3% in 19% in 2018. In the later stages this was spurred by legislation (SB350) passed by the previous Governor, Jerry Brown, in 2015 which had mandated 33% of electric energy come from renewable sources by 2020, and 50% by 2030 (**Renewable Portfolio Standard – RPS**). This is monitored and enforced by the California Energy Commission (CEC).
- California was one the first to establish a **Cap and Trade Program**, which is market based approach. In summary, it assesses the total carbon emission by the big emitters and

issues allowances which later were auctioned. Over time the allowances are decreased so that the large emitters have to decrease their emissions or purchase allowances from those who have done more than their allowance. The program is a very complicated one that is described in detail in the accompanying website. To date, most emissions reductions have come from renewable energy increases and not from Cap and Trade. However, the California Air Resources Board (CARB) reported that as of 2018, the auctions from the sales of allowances to companies had gone to the Greenhouse Gas Reduction Fund (GGRF). From this the legislature had appropriated \$6.1 billion, out of which \$3 billion had been selected and \$2 billion implemented in “Green” projects intended to reduce greenhouse gas emissions.

- **Goal of Carbon Neutrality by 2045:** In 2016, the previous Governor Jerry Brown signed legislation (SB100) that mandated that ALL (100%) electric energy in the state be carbon neutral by 2045 (meaning that all sources were admissible in this number as long as it did not emit carbon dioxide). This differed from previous legislation and requirements that a certain percentage be from only renewable energy (like solar and wind). However, Governor Brown went one bold step further. He signed an executive order mandating ALL energy (not just electric energy which is only about 10% of all energy consumed) be “carbon neutral” by 2045. The details of the law allow many options, because of which the energy mix can include nuclear, large hydro and natural gas with Carbon Capture and Storage (CCS).
- **Accompanying Increase in Renewable Energy:** For Electric Energy only, the bill (SB100) also increased the requirement that 50% electric energy be from renewables by 2026 (that does not include nuclear), and 60% renewables by 2030.
- Here are the achievements and goals in the **Transportation Sector:** California has always led the US in terms of established Corporate Average Fuel Economy Standards (CAFE) that require higher fuel efficiency for vehicles. California already has more electric cars than the other states. Governor Brown had also signed an executive order that established the **goal of having 5 million electric vehicles in**

California by 2030, and to establish 250,000 zero-emission vehicle chargers (that provide a slower charge), including 10,000 DC fast chargers by 2025 (which charge in a much shorter time, but need higher power). Initially, the California Energy Commission (CEC) is funding about 100 hydrogen refueling stations throughout the state which are required to have at least 33% renewable hydrogen, with those supplying more than 40% renewable hydrogen eligible for a credit.

Efforts of the Government of California

The four agencies of the Government are the California Energy Commission (CEC), the California Air Resources Board (CARB), the California Public Utilities Commission (CPUC), and California Independent System Operator (CAISO). These organizations are engaged in different aspects of energy and Climate Change solutions activities. Efforts are being implemented that are aimed at building decarbonization – mainly electrification.

Challenges faced by California: The state will have a much easier time achieving the energy and emissions reductions goals in electric energy. But California faces big challenges in the energy and climate sectors by the way of decarbonization (mainly electrification) in the areas of transportation (with a large number of fossil fuel vehicles on the road that are increasing their vehicle miles traveled), in residential and commercial buildings, and in Industry.

So here is the Plan for California.

The current and proposed energy plan pie charts are shown below. The plan for California will mirror that proposed for the US above, as well as draw on the Global Plan, with the following added notes:

- ☐ **California needs a phased and time bound program to replace its natural gas power plants with solar plus battery storage units – keeping only a few operational to deal with the variability of renewables until such time as other alternatives are developed.**
- ☐ **California is well poised to develop solar electric highways that vastly expand its electric charging stations throughout**

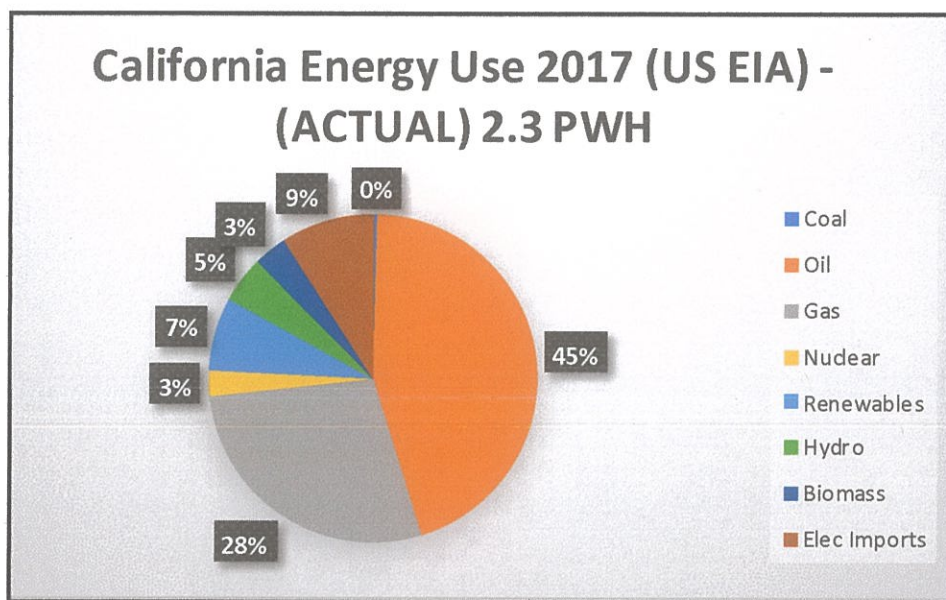
the state. Adopting the concept of solar-electric highways and roadways will make it much easier for California to blanket all land areas with solar-electric charging and green hydrogen refueling stations.

- **Vehicle Replacement:** California had 31 million vehicles on the road as of 2010. If 5 million electric vehicles are on the road by 2030 (California's current goal), assuming that they have replaced fossil fuel vehicles, then there still will be 26 million mostly fossil fuel vehicles on the road (assuming no growth in numbers). So from 2031 and 2050 the combined growth in battery electric vehicles and fuel cell vehicles (using hydrogen) and a "Cash for Clunker's" type program will need to be about 1.3 million vehicles a year. With this, there will be NO fossil fuel vehicles on the road by 2050. The Plan calls for all fossil fuel vehicle sales to end by 2035, so that the replacements for those can begin in 2045.
- With significant capabilities for clean energy research and development, the state should undertake the **RDD&D (Research, Development, Demonstration & Deployment) of the green production of storage fuels like hydrogen and ammonia**, and in their end use in electricity generation, transportation, shipping, and industry. The state is leading the US in establishing hydrogen refueling stations for cars, especially encouraging "green" hydrogen produced from renewable energy. The State needs to up its ambition considerably so that by 2050 it has about 9% of its energy coming from hydrogen and ammonia.
- The State can also pioneer in the US in terms of the **full scale electrification of homes, commercial buildings, industry, and agriculture** – transitioning what cannot be electrified with innovative technologies for storage fuels.
- With electrification, the electric energy demand will be 3 to 5 times what it is today. The State needs to build as much solar PV generation within cities or near cities, so as to reduce the need and expense of transmission lines. Still, with the **expansion of renewable energy based generation the transmission grid expansion** needs to be undertaken, and significant storage capacity developed locally (such as large battery systems) in order to deal with the variability of renewable energy.

- With the massive wildfires that have occurred in recent years, the State needs to undertake at a very high level, **Disaster Risk Reduction in regard to preparing for wildfires**, of the type described above by building fire breaks in existing forests, and designing new afforested areas with fire breaks so fires are easy to control. Massive programs need to be undertaken.
- **Carbon Sinks – Forests:** California should take up its share of the 80 million hectares that is the goal for the US in terms of reforestation and afforestation, with the areas designed to enable ease in control of wildfires, as described above. The reforestation of wildfires needs to be specially designed on these principles, with special attention paid to the locations of buildings and homes, and building fire defensible spaces around them.
- **Carbon Sinks – Coastal Ecosystems:** California is well poised to establish all types of coastal ecosystems along its entire Pacific coastline, coordinating with fishery experts to enhance the habitats for all kinds of fish and ocean life.
- **Low Carbon Transportation:** California has begun its investment in **high speed rail** along the coast. It should review the whole process and design and see how this can be expedited so as to establish this early. This will cut down vehicular traffic. California needs a statewide plan for low carbon transportation that will parallel that of the US – pedways, bikeways, mass transit, rail transit, solar-electric roadways, high speed rail and airports all integrated.
- **Just Transition:** The oil and natural gas industry is quite active in the state. California and the US and other fossil fuel dependent nations need programs and policies in place that help the companies, workers and communities involved in fossil fuel activities to transition to the new clean energy renewable economy. More on this follows.
- California needs to begin **enforcing its rules for its Cap and Trade Program**, so that the allowances of all polluting sources covered by the program are reduced to zero by 2045, and most of its auction proceeds are invested in implementing the above Plan. It is estimated that if the Cap and Trade program succeeds, it will reduce its greenhouse gas emissions by 15-20%.

- California needs to coordinate with national US policies in beginning the shut-down of its oil refineries and the possible conversion of these facilities to the making of storage fuels using renewable energy sources. The import of oil and the export of refined oil products need to be coordinated along with a Just Transition for all of its oil industry and natural gas industry workers.

We now present a snapshot of California's Energy Consumption during 2017.

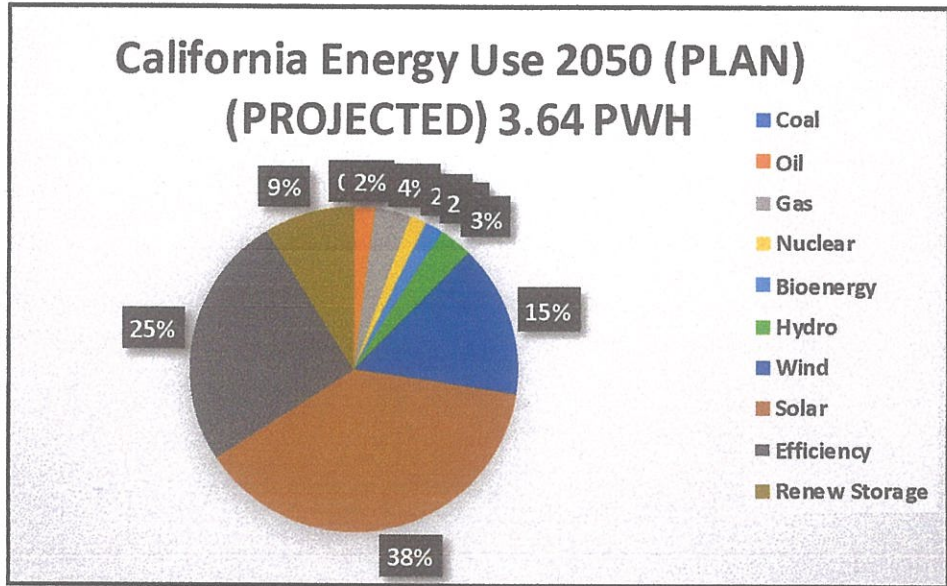


CALIFORNIA ACTUAL ENERGY USE IN 2017

This information is from the US Energy Information Agency – profile for California. Coal use is very small, essentially zero, but oil use is 45% and Natural Gas is 28%. Combined, dependence on fossil fuels is at 73%. Note that imported electricity is about 9% of total energy use. PWH = petawatt hours (10E15 Watt Hours, or 10E12 kilowatt hours).

The Plan for California is essentially to achieve carbon neutrality by 2050 totally by fossil fuels. This can certainly be speeded up to be achieved by 2045, if the state wishes to meet its time bound goal by 2045. The reforestation and afforestation, and coastal ecosystems expansion are treated as bonuses because of their uncertainty, but they can be significant insurance that California more than meets its

goals of reducing carbon and greenhouse gas emissions. California has a very good record of implementing energy efficiency activities, so the goal set is at 25%. Storage fuels are estimated at 9% of the increased energy. However, if energy efficiency does not achieve the necessary reductions, then storage fuels production and use can correspondingly expand. Here is the Plan for 2050.



CALIFORNIA ENERGY PLAN FOR 2050

Fossil fuels are down to about 5-6% (essentially gone) with the gas component larger. Solar PV has a big expanded role at 38%, with wind coming in next at 15%. If efficiency is excluded, California’s actual energy use grows from about 2.3 PWH in 2017 to about 3.64 PWH by 2050.

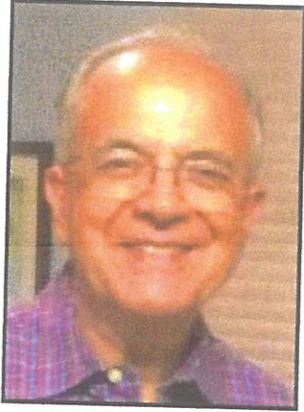
Along with the European Union, California has always led the world in energy and Climate Change solutions. It is time for the state to up its ambitions in line with what is needed to achieve the 1.5 C goals and implement a Plan such as described above. There is much that the US and the world can learn from California as they begin to implement their national and Global Plans. This can provide the motivation and information that will lead to effective global treaties, effective actions by other nations, and an effective implementation of a US national plan.

[35] “Annual Energy Outlook 2020 – with Projections to 2050,” or AEO 2020 Report, United States Energy Information Agency, US Department of Energy, January 2020. www.eia.gov/aeo

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ABOUT THE AUTHOR



The author Dr. Harinder (Hari) Singh Lamba, has experience in engineering, business and ecology. He has a Ph.D. in engineering from the University of Illinois at Urbana-Champaign, with about 40 years of experience in industry, both in engineering product development and in advanced technology. He migrated from India to the USA in 1970 with a bachelor's degree in Aeronautical Engineering. He was one of the founders of the

Earth Summit Network, an informal organization formed in Chicago in 1991-92 to educate the local public about the Earth Summit, or the United Nations Conference on Environment and Development (UNCED) that was held at Rio de Janeiro, Brazil in 1992, where the original global warming treaty was signed. Since then he has been active in non-profit groups, talking about and making presentations on Climate Change.

Through his volunteer work and through self-education, he has also developed a good understanding of environmental (ecological), developmental (technical, economic, industrial and financial) and political (democracy) issues. **Because of his background, he has the unique ability to understand all aspects of the Plan and its solutions needed in energy, climate, economic development and ecosystems.** He has published a number of technical engineering papers and has technical patents. He is the author of a number of books including, "Rethinking Progress – Towards a Creative Transformation of Global Society;" and a "Personal Climate Change Handbook;" 2016, a 40 page book that is available on Amazon. ~~See below for a list of the author's books.~~ The author's aim in this activity is to see the Plan accepted, and something like the Plan implemented globally in a timely and effective manner.